McKenzie

Senior Thesis

Geology and Mining History of Two Proposed Reclamation Sites of the Wilds, Muskingum County, Ohio

by

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ABSTRACT

Abandoned strip-mined lands in Ohio are being reclaimed under state and federal regulations. The abandoned lands are required to be returned to the same or better condition than before mining. Many reclaimed areas, including the Wilds, are being returned to productive uses that consist of recreation areas, wildlife areas, golf courses, and pastures. Two sites at the Wilds in Muskingum County, Ohio were chosen for this study. Neither site was suitably reclaimed using lime fertilizer. The proposed reclamation project at the Wilds is to examine the effectiveness of N-Viro Soil, a bio-organic aglime topsoil, on the two sites. The N-Viro Soil is expected to adjust the pH of the soil, increase nutrients, and add organics. Although the project was designed for continuing research, the information gathered from previous projects suggests that predictions can be made about the effectiveness of the N-Viro Soil on the current two sites.

INTRODUCTION

The problem of environmental degradation caused by surface mining is widespread and serious. Surface mining drastically alters the ecological characteristics of the area disturbed and can have an effect on surrounding areas. Vegetation is removed, topographic features and characteristics are changed, and the original geological surfaces and soils destroyed. This has resulted in areas of unsightly landscapes and soils that are essentially useless. This paper was designed to investigate the effect of N-Viro Soil in reclamation of surface mine spoils.

The study area is in a 9,154-acre wild-animal preserve, the Wilds, located in Muskingum County, Ohio. The Wilds, originally known as the International Center for the Preservation of Wild Animals, is located 15 miles southeast of Zanesville, Ohio (Figure 1). It is 14 miles to the west of the village of Cumberland and 15 miles southwest of

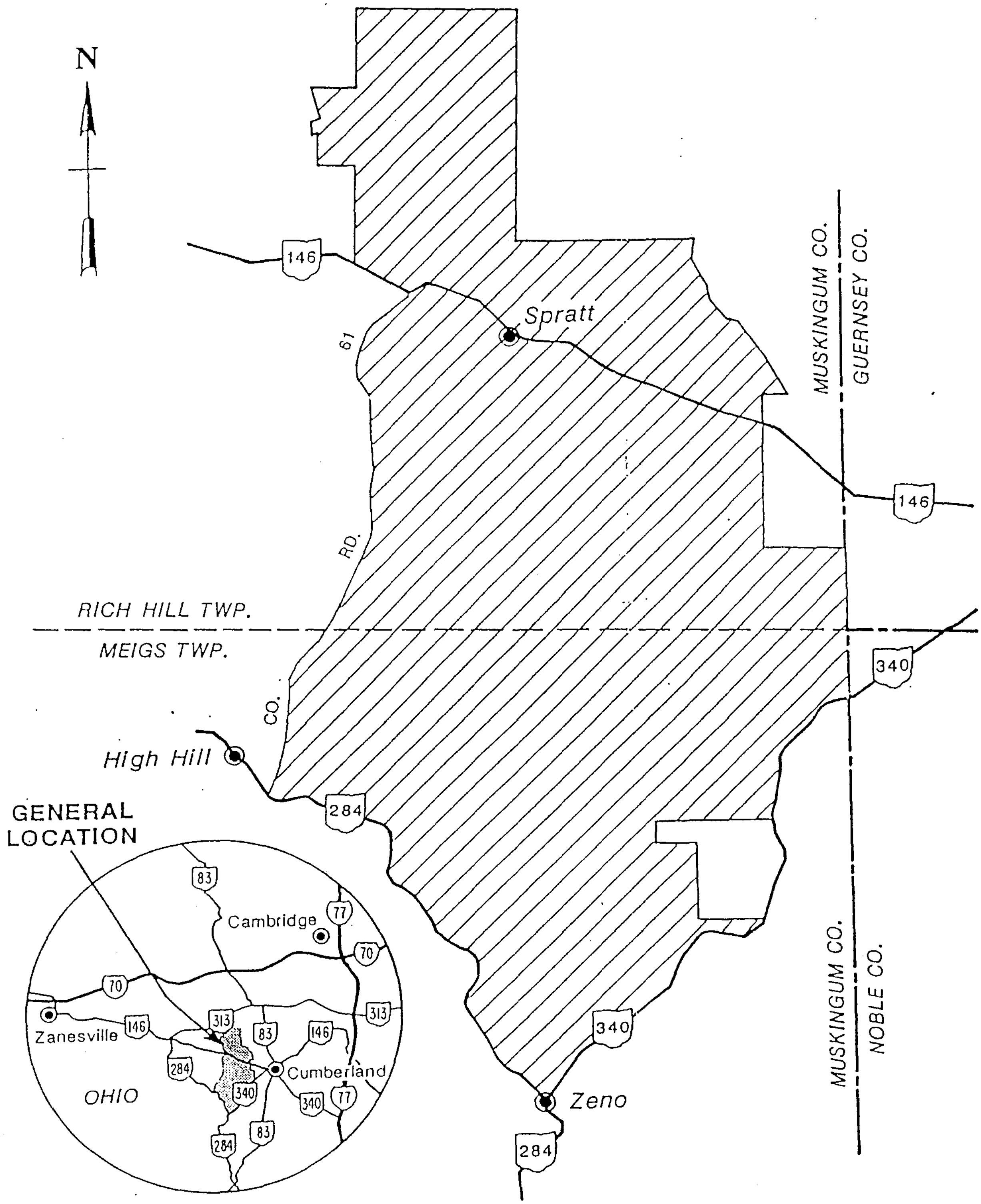

Figure 1: Location of the Wilds (Source Unknown).

Cambridge. The preserve's goal is as a breeding center for rare and endangered species of animals as well as a wild animal research center and educational facility (Artzner, 1994). Some of the wildlife species include the southern white rhinoceros, Przewalski's wild horse, North American red wolf, Bactrian camels, Scimitar-horned oryx, Cuvier's gazelle, and Trumpeter swans. The preserve opened to the public in 1994.

The preserve's land was originally surface mined for coal and limestone. On July 30, 1986, this land was donated to the Wilds by the American Electric Power and Ohio Power Company (Brennan, 1986). Most of the land had been reclaimed under Ohio's strict reclamation laws. These laws, which took effect in 1972, required that the land be returned to the same or better condition than before mining (BUSML, 1974). The reclamation included resloping the land, laying down of topsoil, and the reseeding of grasses and trees. Today, the Wild's landscape includes lakes, woodlands, wetlands, and grasslands.

Although the title to the land was passed to the Wilds in 1986, the mineral rights remained with oil companies, coal companies, and earlier landowners. Parts of the land now occupied by the Wilds have been sites for oil and gas wells. Many of the wells, drilled from the Conemaugh Group, are still producing.

The two sites chosen for this study had not been returned to suitable condition after reclamation efforts. The Well Site was reclaimed under the 1972 reclamation laws and may have been impacted by the activity of the nearby well. As a result of destructive spoils and soils at the well sites and waste produced by hydrocarbons, well sites are commonly sparsely vegetated.

The North Site was reclaimed under the 1977 reclamation laws and may have been impacted by vehicle traffic from the numerous nearby roads. The use of the N-Viro Soil is expected to adjust the pH of the soil, increase nutrients, and add organics. If the N-Viro soil demonstrates a positive effect, it could be useful in future strip mine reclamation efforts.

MINING IN OHIO

Ohio has a long history of mineral and natural resource production. Many of Ohio's counties depend on mineral extractions as their dominate industries. One of the earliest mined minerals was flint. The most abundant occurrence of flint is located at Flint Ridge which extends from Licking County, south to Muskingum County. Flint's earliest use was by Ohio Indians and later by settlers. A variety of objects including knives, arrowheads, and spearheads has been traced to a Flint Ridge source (Collins, 1987).

Another mineral resource used by early settlers was salt. The salt was obtained from natural brines produced from wells located in the Mississippian and Pennsylvanian-aged sandstones (Collins, 1987). Meigs County was the most successful salt industry, though the industry was also developed in Columbiana, Guernsey, Hocking, Morgan, and Tuscarawas Counties. Rock salt was later discovered in northeastern Ohio, particularly Cuyahoga, Lake, Medina, Summit, and Wayne Counties.

It was not until the 1860's that heavy exploration of gas and oil was undertaken in Ohio, though the presence of oil in Ohio had been known even by the earliest settlers. The Indians and European settlers found small amounts of petroleum on the surface of streams and used it for medicinal purposes (Collins, 1987).

The first serious efforts for commercial gas and petroleum development occurred mainly in the northwestern portion of Ohio. The Lima-Indiana field was the first "giant" field in the United States, reaching a net production peak of 24 million barrels in 1896 (Collins, 1987). The industry was later developed in the eastern section of the state. Gas and oil fields extend from Cuyahoga County in the north to Lawrence County in the south (Figure 2).

The Division of Oil and Gas estimates that 822 new wells were drilled in Ohio in 1993 (Weisgarber, 1994). The top five counties were Muskingum, Coshocton, Holmes,

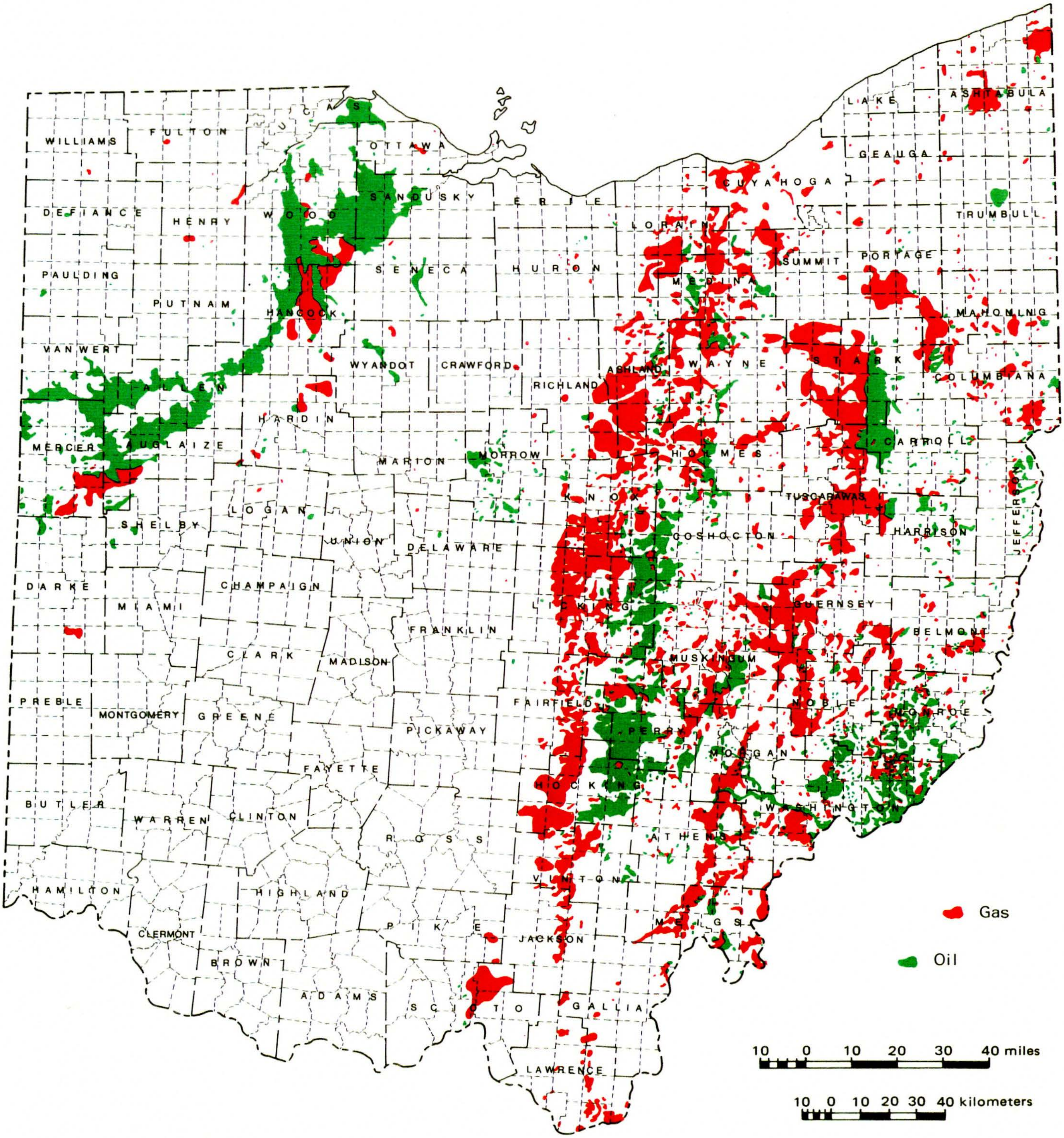

Figure 2: Oil and gas field map of Ohio (Ohio Geological Survey).

Portage, and Stark. In Muskingum County, 61 new wells were drilled with 45 wells productive. The oil and gas industry is still a major contributor to the state's mineral economy, though production decreased by 6.2% in 1993 (Weisgarber, 1994).

Small amounts of gypsum are also mined in Ohio. A substantial industry is located in Ottawa County, along the shoreline of Lake Erie. Gypsum is currently used in the manufacturing of plaster, wallboard, and cement (Collins, 1987).

Large quantities of limestone and dolostone are quarried throughout Ohio. Limestone and dolostone are used to produce aglime, cement, glass, and aggregates. Substantial amounts of building stone, especially Berea sandstone, are also mined. Other industrial rocks and minerals include clays, shale, sand, and gravel. These materials have a large variety of uses including tile, pottery, grindstones, pipes, and cement. In 1993, Ohio reported a net production of 47,972,399 tons of sand and gravel (Weisgarber, 1994). This ranks Ohio second nationally in the production of sand and gravel. The majority of sand and gravel is found in fluvial and glacial material in northeastern Ohio (Collins, 1987).

The Coal Industry in Ohio

Coal is Ohio's most valuable mineral resource and has been mined in significant amounts since the late 1800's. Figure 3 shows a graph of coal production in Ohio, dating from 1875 to 1987. The coal industry in Ohio during 1993 produced 27,668,810 tons of coal (Weisgarber, 1994). Figure 4 shows the tonnage of coal produced by county and the methods used during 1993.

Ohio coal resources are located in 30 counties in the eastern and southern portion of the state (Figure 5). These resources lie on the northwestern edge of a structure known as the main bituminous coal basin (BUSML, 1974). The basin extends from north-central Pennsylvania through eastern Ohio, West Virginia, western Maryland, and down into

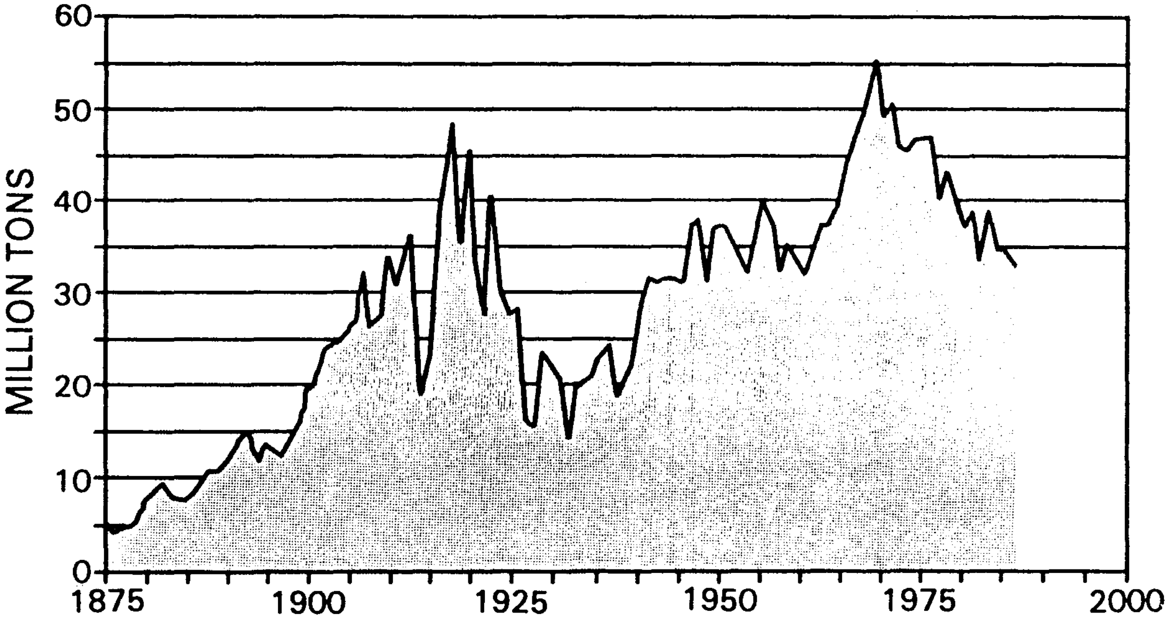

Figure 3: Coal production in Ohio from 1875 to 1987 (Weisgarber, 1994).

County[1]	All methods (short tons)	Total number of mines	Underground					Surface			
			Number of underground mines reporting	Production (short tons)				Number of surface mines reporting	Production (short tons)		
				Total underground	Longwall	Conventional	Continuous miner		Total surface	Strip	Auger
Belmont	5,904,179	21[2]	1	3,968,101	3,075,487		892,614	20[2]	1,936,078	1,771,049	165,029
Carroll	107,572	7						7	107,572	107,532	40
Columbiana	1,131,047	14	3	490,772			490,772	11	640,275	595,962	44,313
Coshocton	1,347,597	14						14	1,347,597	1,263,065	84,532
Guernsey	402,250	8						8	402,250	364,205	38,045
Harrison	2,447,095	13	1	1,175,173			1,175,173	12	1,271,922	1,170,770	101,152
Holmes	153,635	5						5	153,635	153,635	
Jackson	1,250,717	9[2]						9[2]	1,250,717	1,250,717	
Jefferson	1,673,447	22	1	261,792			261,792	21	1,411,655	1,250,576	161,079
Lawrence	9,611	1						1	9,611	9,611	
Mahoning	4,837	2						2	4,837	4,837	
Meigs	2,895,853	2	2	2,895,853	2,453,309		442,544				
Monroe	827,377	1	1	827,377	765,987		61,390				
Morgan	46,549	1[3]						1[3]	46,549	46,549	
Muskingum	2,350,330	3[2]						3[2]	2,350,330	2,240,141	110,189
Noble	1,065,855	8						8	1,065,855	1,054,230	11,625
Perry	395,321	7						7	395,321	325,116	70,205
Stark	230,340	6						6	230,340	230,340	
Tuscarawas	2,388,339	39						39	2,388,339	2,144,064	244,275
Vinton	2,950,455	9[2]	1[4]	853,258	683,015		170,243	9[2]	2,097,197	2,097,197	
Wayne	3,169	1						1	3,169	3,169	
TOTAL	27,585,575	192	9	10,472,326	6,977,798	0	3,494,528	183	17,113,249	16,082,765	1,030,484

[1]Production from mines operating in more than one county was evenly split between the counties involved unless a by-county breakdown was provided by the operator.
[2]Does not include mines extending into this county from adjoining counties.
[3]This mine extends into Morgan County from Noble County and is not included in the total number of mines.
[4]This mine extends into Vinton County from Meigs County and is not included in the total number of mines.

Figure 4: Tonnage of coal produced by county and method during 1993 (Weisgarber, 1994).

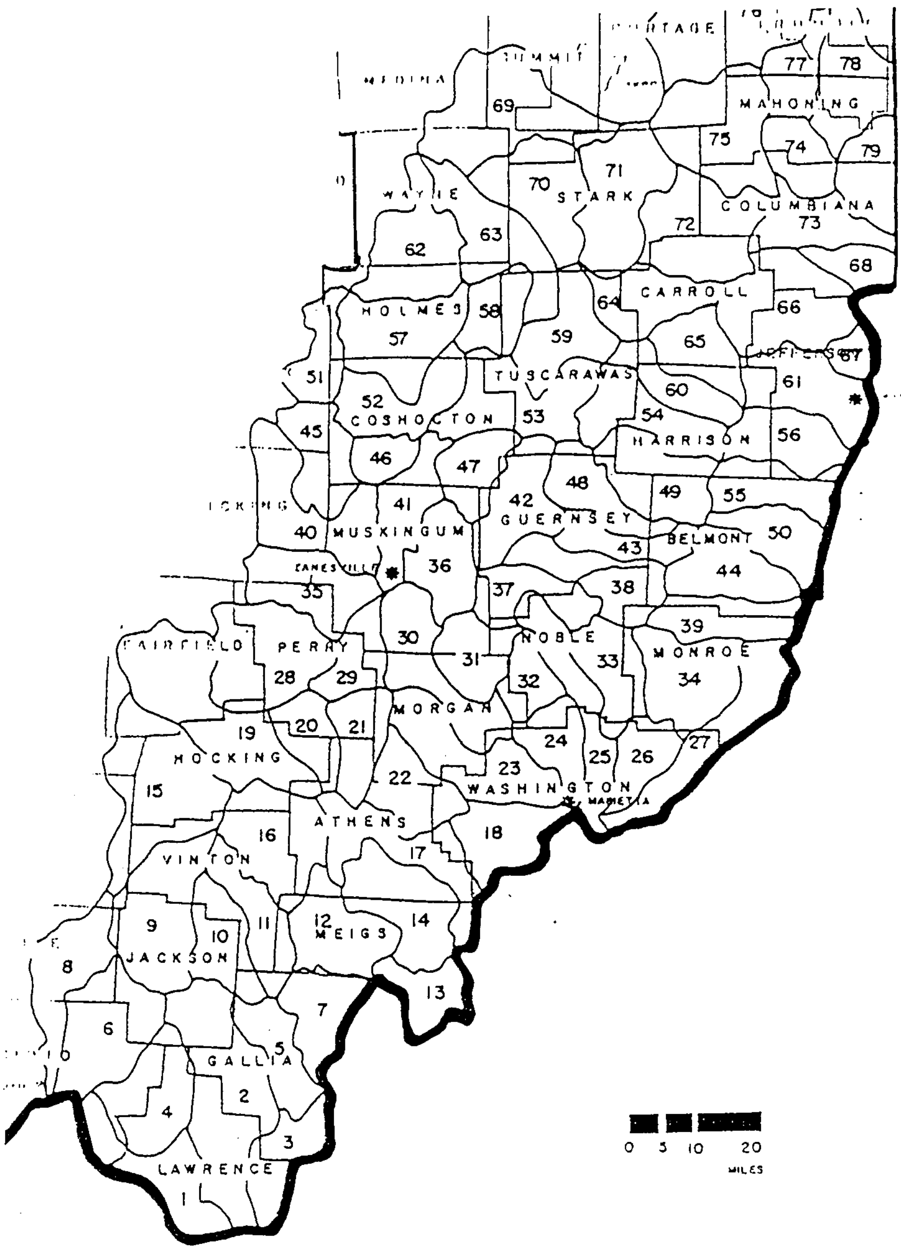

Figure 5: Location of the Ohio coal fields in the eastern and southern portions of the state (BUSML, 1974).

Alabama. Figure 6 shows the location of the basin in the United States. The coal deposits occupy approximately 28,160 square kilometers and are oriented along a 290 kilometer band adjacent to the Ohio River. Coal mined lands are found in the four major river basins: the Scioto, Muskingum, Beaver, and Hocking Rivers. All of the coal mined lands are within the Ohio River Basin.

The Monongahela Group, a coal bearing sequence, is found in many southeastern counties in Ohio, including Noble, Belmont, Morgan, Athens, and Meigs to Gallia counties (Stout, 1918). This group is the main unit mined in Muskingum County.

The Monongahela Group

The Monongahela Group was first described by H.D. Rogers from strata exposed along the Monongahela River in Pennsylvania (Stout, 312). The group extends from the base of the Pittsburgh coal to the shaly sandstones of the Waynesburg member. The rocks of primary interest in the Monongahela group are shales, limestones, coals, clay, and iron ores. All of the strata are of fresh water origin.

The general strata of the Monongahela Group includes twenty-three members. The parts include eight coal beds, six limestones, seven sandstones, and two shales. In Muskingum County, not all of the members are present. The Monongahela formation in Muskingum County only contains four of the coal beds, as well as sandstone, limestone, and shale (Stout, 1918). The formation is approximately 76 meters thick and is present in Bluerock, Meigs, Salt Creek, Rich Hill, and Union Townships. The upper members are only found in Meigs Township.

Coal Formation

Coal is derived from the compaction of vegetation and other organic materials that accumulated in swamps along the shoreline of ancient inland seas (Levin, 1994). The

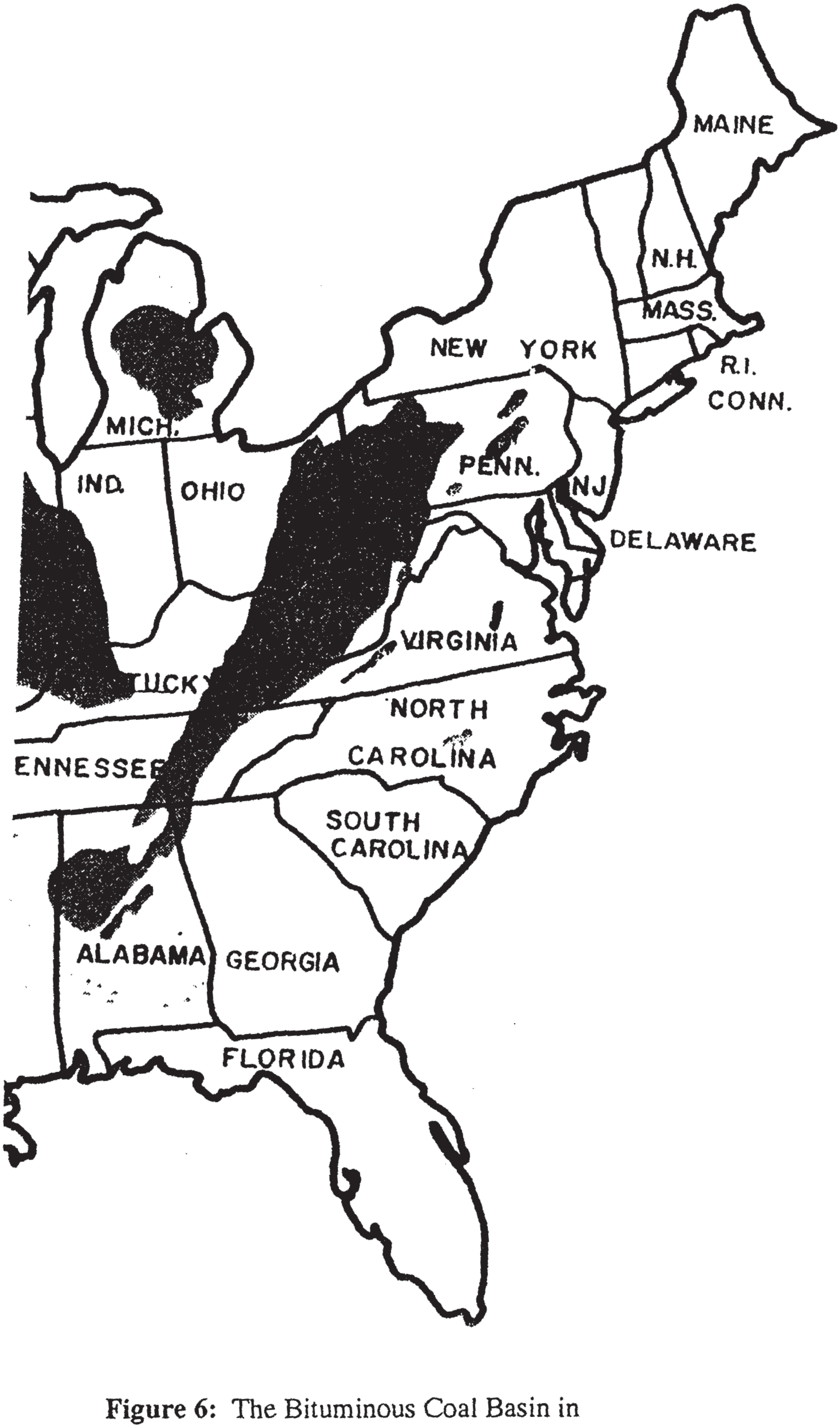

Figure 6: The Bituminous Coal Basin in the United States, extending from Ohio to Alabama (BUSML, 1974).

repetitive formation of the coal layers and the rocks between them was the result of geologic and environmental conditions when the ancient sea existed. The sequence of events involved were the initial formation of the swamp, a general lowering of the land surface due to flooding of the swamp, the accumulation of sediments on top of the flooded swamp, followed by the establishment of a new swamp on the accumulated sediments. These general conditions also produced variations in thickness, geographic extent, quality, and chemical nature of the coal layers.

SURFACE MINING METHODS

The choice of mining methods depends on the geology and topography of the mine site. Various methods include contour, area, and auger mining. The major methods of surface mining are combinations of these three types of mining.

Area mining is performed in relatively flat to gently rolling terrain. Contour mining is conducted where deposits are found in hilly or mountainous areas. Augering, which is drilling horizontally into a coal seam, is usually used with contour mining to increase the coal recovery (CSR, 1981).

Area strip mining is usually limited to lands with fairly horizontal slopes and less than 61 meters of overburden (CSR, 1981). A trench or box cut is made through the overburden to expose the coal. These cuts are made in long, narrow strips. The series of parallel cuts continue across the site until the depth of the overburden or coal quality makes mining unproductive. The final cut leaves an open trench, bounded by a spoil bank and a highwall (Figure 7).

Contour mining is used to extract coal that lines the sides of steep hills, usually 12 to 14 degrees (CSR, 1981). In this method, the overburden is removed from the coal seam, creating a bench with a highwall. After the coal is removed from the uncovered seam, cuts are made into the hillside until the overburden becomes too deep for recovery

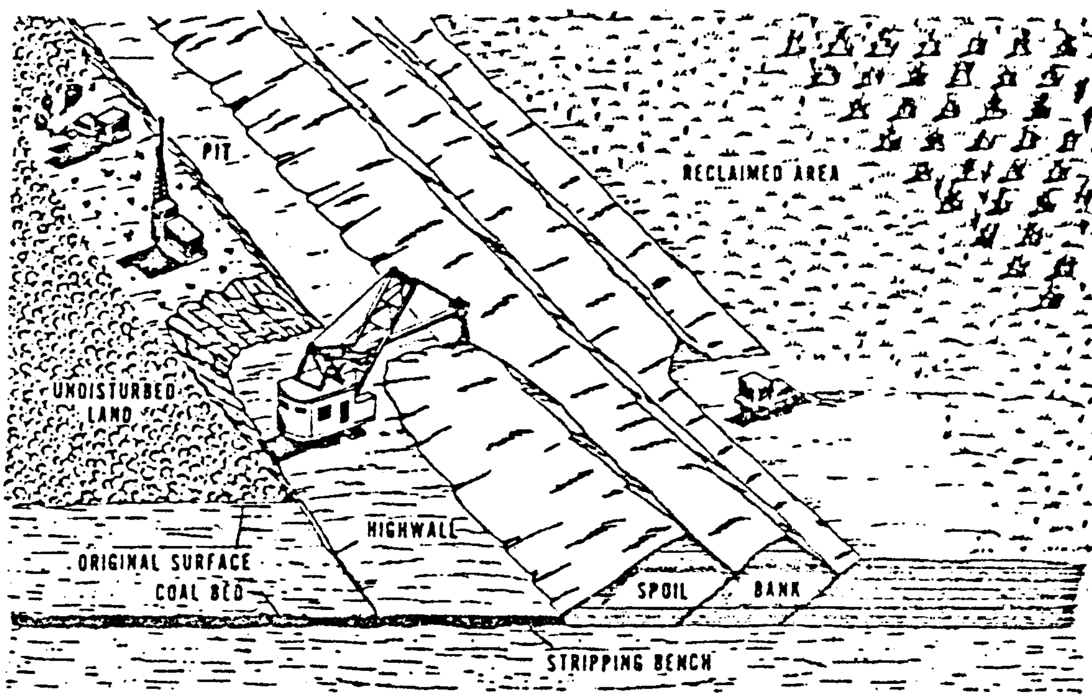

Figure 7: Diagram of area strip-mining (CSR, 1981).

of the coal. This operation continues along the hillside until the seam becomes too thin or the slope too steep (Figure 8).

Auger mining is practiced where contour mining is haulted because of thick overburden or steep slopes (CSR, 1981). Augering is performed directly into the hillside from a narrow bench. It produces coal by boring horizontally into the seam.

In many situations, surface mining techniques are more favorable than other mining methods (CSR, 1981). It has both economic and safety advantages.

RECLAMATION LAWS

In Ohio, the extraction of natural resources, such as coal, by surface mining methods is called strip mining. This activity is nationally regulated under Public Law 95-87 of the Surface Mining Control And Reclamation Act of 1977 (SMCRA, 1993). Since January 1948, the mining industry has been required to reclaim affected areas as described by reclamation laws. In August 1965 and again in April 1972, Ohio's Reclamation Law was amended to provide for more adequate reclamation of the land mined. The final revision was in 1977 and this is the current law in effect.

Under pre 1972 strip mine regulations, the overburden covering the seam was removed, while the rich humus was being deposited on the bottom of the spoil bank. Therefore, the less desirable and sometimes toxic overburden remained on the surface. These spoil banks were sometimes left, or graded to a gently sloping surface. The surface cover produced by this method created a tremendous problem in achieving revegetation of disturbed areas. These problems included acidity, erosion, and texture of the soil (Plass, 1975).

Since the 1972 law, the main purpose of reclamation standards has been to protect the environment. The reclamation standards under Public Law 95-87 include returning surface mined land to its original contour and eliminating highwalls (SMCRA, 1993).

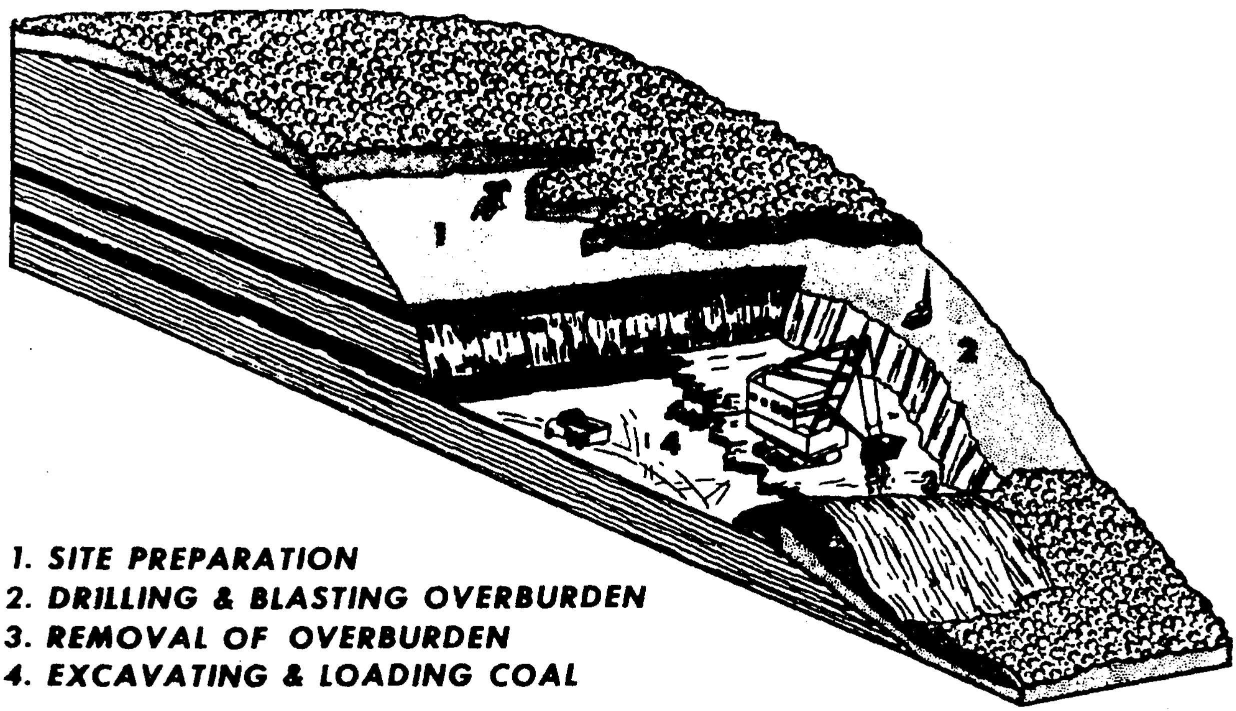

Figure 9: Diagram of contour mining (CSR, 1981).

Affected areas must be resoiled with at least six inches of topsoil or suitable subsoil and all toxic materials covered. The addition of lime or fertilizer is required in order to achieve diverse vegetation such as grasses and legumes. All grasses and legumes must be capable of self-regeneration. Grading and recontouring the affected land must be accomplished within one year following the mining. The entire reclamation process must be completed in three years following the mining of the land (Kraps, 1995).

GEOLOGY OF MUSKINGUM COUNTY

Muskingum County is located in the east-central part of the state and is bounded on the north by Coshocton County and the south by Morgan and Perry Counties (Stout, 1918). Guernsey and Noble Counties are on the east, while Perry and Licking Counties are found bordering on the west (Figure 9). The county lies in the central part of the Muskingum River Basin. The total area of the county is 416,640-acres (Steiger, 1991).

Topography

Muskingum County is part of the unglaciated Allegheny Plateau of the Appalachian Plateau Province (Stout, 1918). The northern, western, and central sections of the county are hilly with wide ridges and gentle slopes and valleys.

The eastern portion of the county is described with steep and rugged hills, caused by crustal uplift, erosion, weathering, and deposition (Stout, 1918). The ridges and valleys are narrow and commonly have steep side slopes.

Glacial Effects

The last glacial period, the Wisconsinan, did not enter Muskingum County, though it did affect the area (Stout, 1918). The melting ice sheets caused erosion. Much of the

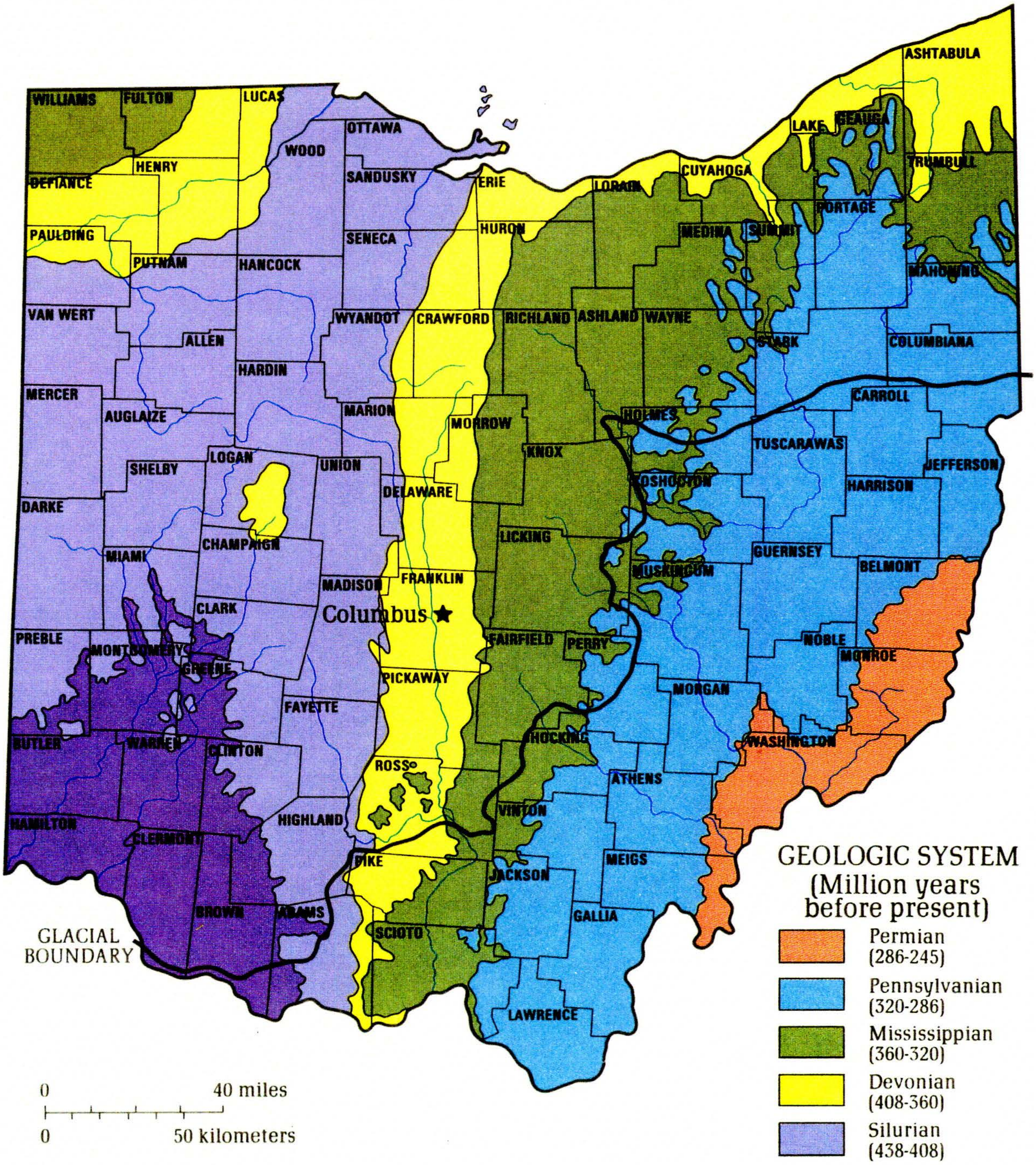

Figure 9: Location of Muskingum County in Ohio (Weisgarber, 1993).

sediment in the river valleys was a direct result from the outwash during the Wisconsinan glaciation.

Climate

Ohio is in the north temperate climate zone. The climate is classified as humid with warm summers and mildly cold winters (Sanderson, 1950). Temperatures average from 49.7°F in northern counties to 56.6° F in the southern counties. Maximum temperatures range from 103° F to 107°F and minimum temperatures range from -33°F to -17° F. The annual precipitation is 48 inches. The average length of the growing season varies from 146 to 163 days. The first and last frosts occur in October and May respectively.

Stratigraphy

In the western portion of the state, only two formations of Mississippian-aged strata are present. The strata in Muskingum County mainly belongs to the Pennsylvanian System. They have an approximate thickness of 326 meters (Stout, 1918). It consists of sandstones, conglomerates, shales, coals, clays, limestones, iron ore, and flint. The rocks and coals of this county are of sedimentary origin and were deposited in or around water. The rocks have a general dip to the south and east (Stout, 1918).

The Mississippian System contains the Logan and Maxville formations. The Pennsylvanian System contains four formations, the Pottsville, Allegheny, Conemaugh, and Monongahela. The Pottsville is the oldest formation and the Monongahela formation is the youngest. A general stratigraphic section of Muskingum County is found in figure 10.

Geology of Rich Hill and Meigs Creek Townships

The location of the Wilds is in Rich Hill and Meigs Creek Townships, positioned in the southeastern section of the county. The area has narrow ridges and valleys with steep

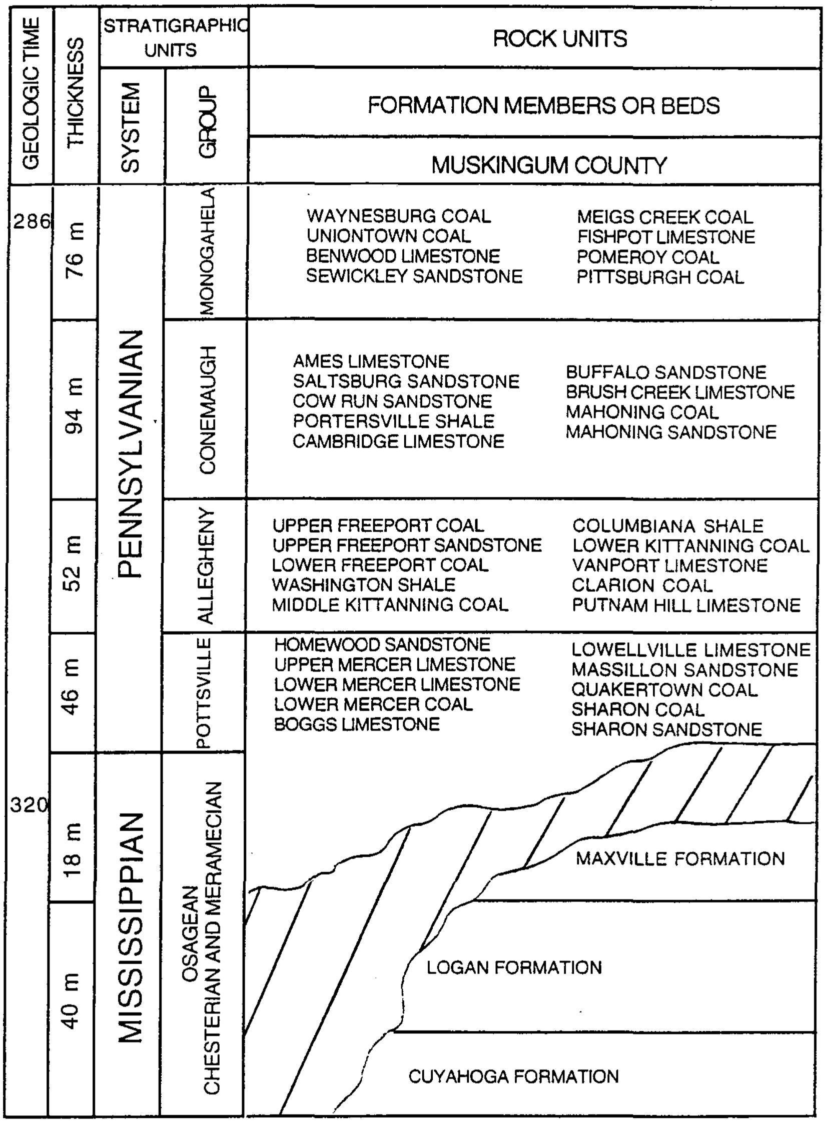

Figure 10: The general stratigraphic section of the Monongahela Group in Muskingum County, Ohio (Hull, 1990).

slopes. The strata consists of sandstone, conglomerates, shales, clay, coal ,and limestone (Stout, 1918).

The soils of Rich Hill and Meigs Creek Townships are generally of two associations, the Lowell-Guernsey-Gilpin and the Morristown-Fairpoint-Bethesda (Steiger, 1991). The major soils in the Lowell-Guernsey-Gilpin Association are formed in colluvium from the underlying bedrock of clay, shale, limestone, and siltstone (Steiger, 1991). These soils occupy ridges and hillsides that are strongly sloping to very steep. The soil ranges from moderately well drained to well drained.

The Morristown-Fairpoint-Bethesda Association are soils located in and around areas that have been surface mined (Steiger, 1991). These soils occupy a sloping to very steep topography and are composed of clay, shale, and limestone fragments. These soils are considered to be well drained.

THE IMPORTANCE OF RECLAMATION

Surface mine reclamation has many positive benefits. It can improve the topography of the land, fertility of the soil, and the economic value of the original mine site and surrounding areas (Plass, 1975). Ultimately, reclaimed mine sites are returned to many productive uses including recreation areas, golf courses, wildlife areas, parks, farms, wetlands, housing developments, and pastures. Without reclamation efforts, threats to the environment would be present. These threats are acid-mine drainage and erosion and sedimentation (McKenzie, 1979). Because of these threats, adequate control of water drainage from the mine site is an important aspect of the reclamation process.

Spoil banks, a heterogeneous mixture of sandstone, limestone, shale, and soil, begin to weather and erode as soon as mining operations begin. Spoil material weathers and erodes rapidly, carrying particles into streams. How severe the erosion is depends on the steepness of the slope and the amount of precipitation (Plass, 1975). Landslides, haul roads, and poor road design also contribute to erosion problems (McKenzie and Studlick, 1979).

Soil erosion and sedimentation cannot be totally eliminated but covering the soil with vegetation can control the erosion (Plass, 1975). Revegetation includes soil preparation, seeding and planting, and irrigation. The type of revegetation used is determined by the acidity of the soil, fertility of the soil, slope of the affected area, and the proposed future use of the site.

N-VIRO SOIL

N-Viro Soil is a granular, soil-like material that results when cake sewage sludge is mixed with cement or lime kiln dust or another type of alkaline admixture (Burnham et al., 1990). N-Viro Soil makes an excellent material for use in reclamation of surface mine spoils due to its physical and chemical properties.

N-Viro Soil has been used in over 30 areas worldwide, including Australia, England, and the United States (N-Viro International Corporation). N-Viro Soil was honored in 1990 by the United States Environmental Protection Agency with the first place award for Sludge Utilization Technology Development. It also received a Presidential Citation for excellence in Innovative Development of Technology for the nation's Environmental Challenge Award's Program.

The benefits of N-Viro Soil include its ability to adjust pH, immobilize metals, increase nutrients, and add organics. The product has been useful to farmers, land reclamation contractors, and land fill operators.

The N-Viro Process

The N-Viro process begins with the mixing of dewatered sludge and alkaline admixtures (N-Viro International Corporation). The blended mixture is then exposed to accelerated mechanical drying and chemical heat pulses, a twelve hour process. The chemical heat pulse, between the sludge and alkaline admixture, raises the temperature to 52 degrees Celsius and the pH level to 12 of the blend. After a 3-7 day drying period, the N-Viro Soil is ready for use. Because of N-Viro Soil's stability, it can be safely stored for extended periods of time.

Hopkins County, Kentucky

N-Viro Soil has proven effective in many applications including reclamation of an acid mine spoil in Hopkins County, Kentucky. In October 1988, 100 tons per acre of N-Viro Soil was applied to the project site (Logan et al., 1994). The area was seeded with a mixture of orchard grass, white sweet clover, blue grass, and sericea lespedesa. In the spring of 1990, the project area contained thick grasses and showed evidence of wildlife habitance. The pH of the soil was increased to the range of 6.0 to 7.3. This was quite an effective increase from its previous pH of 2.5.

HISTORY OF THE NORTH AND WELL SITE

Two sites in the Wilds were chosen for this study, one known as the Well Site and the other the North Site. Each site was reclaimed under different reclamation laws.

The Well Site is located in Rich Hill Township. This portion of the Wilds was mined by Central Ohio Coal Company using the area strip-mining method. When the mining of the Meigs Creek No.9 Coal ceased, the acreage mined was reclaimed under the 1972 reclamation laws. Reclamation included filling, grading, resoiling, and planting trees.

As the name implies, the Well Site is located near a gas well which may have influenced the reclamation efforts. As a result of destructive spoils and soils and waste produced by hydrocarbons, this site is sparsely vegetated (Figure 11).

Figure 11: The Well Site displays sparse vegetation.

The North Site, located in Meigs Township, was also mined by Central Ohio Coal Company. The unit mined was the Meigs Creek No.9 Coal, extracted using the area strip-mining method. When the mining activity ended, the area was reclaimed under the newest reclamation law. The Reclamation Act of 1977 insured the elimination of highwalls. Most of the acreage has been reclaimed in grasslands. The North Site reclamation may have been impacted by the traffic of nearby roads (Figure 12).

Both sites were mined by a machine nicknamed Big Muskie. Big Muskie is the largest strip-mining machine ever built (McInnis, 1989). Its cab and machinery enclosure is 140 feet long, 120 feet wide, and 40 feet high. It can scoop up 325 ton bites and relocate its load a few hundred feet away. When the mining is finished, Big Muskie returns the fill and topsoil. Big Muskie is no longer in service, but remains on display in Muskingum County.

THE PROPOSED RECLAMATION PROJECT AT THE WILDS

The proposed reclamation project at the Wilds is to examine the effectiveness of N-Viro Soil on acid-mine spoils. Two sites were chosen for the project.

The characteristic topography of the area surrounding the sites displays gently rolling hills and valleys (Figure 13). The two sites chosen are areas that had been strip-mined and not reclaimed successfully using lime fertilizer.

The two sites are the Well Site and the North Site. In October 1994, each site was divided into eight plots, into which the soil will be laid.

At the Well Site each 5m x 10m plot was marked off using small flags (Figure 14). A sample of soil was collected from each plot to be analyzed. The pH of the soil was 3.05 and contained a large amount of shaly fragments.

At the North Site, each 4m x 5m plot was also marked by small flags (Figure 15).

Figure 12: The North Site, located in Meigs Township.

Figure 13: The gently rolling topography of the Wilds.

Figure 14: The Well Site displaying the eight 5m x 10m plots.

Figure 15: The North Site plots.

A sample of soil from each plot was collected to be analyzed (Figure 16). The pH of the soil was 3.05

One truckload of N-Viro Soil was delivered to each of the sites in February 1995. The product will be applied and seeded in the spring of 1995. The type of vegetation to be implemented has not been established.

Approximately six months after application and seeding, soil samples will be collected from each plot at both sites. The samples will be analyzed for pH, EC, and total metals present. Sampling will then be conducted once a year for approximately five years to determine the productivity of the sites and the changes in vegetation.

SUMMARY AND CONCLUSION

As has been shown in the descriptive portions of this study, the nature of surface mining requires disturbing the land surface in serious ways. Vegetation is removed, topographic features and characteristics are changed, and the original geological surface and soils destroyed. This has resulted in areas of unsightly landscapes and soils that are essentially useless.

The effect of N-Viro Soil has proven successful on other surface mine spoils. The product acts as a physical matrix, helping to rebuild the damaged land. N-Viro Soil is beneficial to the area by increasing nutrients, adjusting pH, and adding organics to the soil. The presence of organic matter in the soil will increase water holding capacity and improve the soil structure. N-Viro Soil has proven to be a positive effect on acid-mine spoils and could be useful in future strip-mine reclamation efforts.

Figure 16: Lori Goins(right) and Billie Harrison collect a soil sample from the North Site.

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